Imaging polarimetry of comets

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Abstract

Remote imaging polarimetric observations is an invaluable tool to provide information on the physical properties of dust in comets. The observed different comae regions and their evolution are important diagnostics of e.g. heterogeneities of composition, size distribution. Different comets were observed from the 80cm telescope at Observatoire de Haute-Provence.

1. Introduction: Different comae regions

Linear polarization imaging of the scattered light by solid particles in cometary comae allows to emphasize different comae regions with different physical properties of the dust and their evolution and spatial variations (e.g. [1,2]). On the polarization map of the main fragment of comet 73P/Schwassmann-Wachmann 3, the different regions can be detected: high polarization regions and a lower polarization region around the nucleus between the jets during some phase of its rotation (Fig 1).

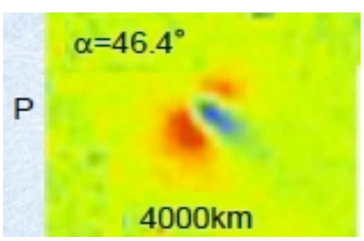

Fig. 1. Comet 73P-C/Schwassmann-Wachmann 3 polarization map. High polarization in the jets, a lower polarization in the nucleus region. Photocenter at the center of the image. Adapted from [3]

2. Comet 103P/Hartley 2 and comet C/2009 P1 (Garradd) and their jets

2.1 Comet 103P/Hartley 2

This comet was also observed by the EPOXI mission [4] at phase angles in the range 46°-59°. Narrow band, ESA, continuum filters were used. A good correlation was observed between (i) the position angles of the high polarization regions and the position angle of the jets and (ii) of their rotation period [5]. Two relatively short jets situated on the two sides of the solar direction were noticed on the treated intensity images and the polarization maps. Increasing aperture polarization values will also be discussed considering the jets rotation. The remotely observed two jets were related to the nucleus shape and rotation observed fas erived from in-situ data [6].

2.2 Comet C/2009 P1 (Garradd)

This large comet with curved or linear jets depending on the observation period was observed in a phase angle range 28°-35°. Important variations in jets structures and in polarization maps were observed with changing heliocentric distances and, probably, orientation of the rotation axis [7].

5. More recent observations

Some more recently observed comets will be presented e.g. C/2012 L4 (PANSTARRS) with higher polarization jets than the surrounding coma (α=38°), 290P/Jager with a more negative polarization at the photocenter and some structures (α=15°) [8], and if possible, preliminary results for comets which we expect to observe in May 2014: comet 209P/LINEAR at $\alpha \approx$ 99° and comet C/2012K1 PANSTARRS at $\alpha \approx$ 32°.

6. Imaging and integrated polarization

If the fluxes are integrated on an aperture, the variation of polarization with increasing apertures can be deduced. The so-called whole coma polarization can be compared to the values for other comets at similar phase angles. Figure 2 presents the polarization phase variations for different comets, in the red wavelength domain. The whole coma polarization synthetic fit is between the jets polarization values (above) and the so-called polarimetric halo values (below).

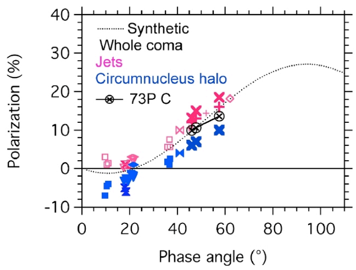

Fig. 2.Comparison of the polarization values in jets, polarimetric haloes and whole comae. Adapted from [9]

6. Conclusions

In correlation with the brightness images and eventually with other techniques, imaging polarimetry allows us to emphasize the different physical properties of dust (size distributions, structure, composition represented by the complex refractive indices) in the different regions of a cometary coma and their evolution during short or longer periods.

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